BULLETIN OF
THE NEW YORK
ACADEMY OF MEDICINE

VOL. 10 JUNE, 1934 No. 6

ANNUAL GRADUATE FORTNIGHT
"DISORDERS OF METABOLISM"
October 23 to November 3, 1933

*Round Table Conference on Diabetes Mellitus**

DIETARY TRENDS

ROLLIN T. WOODYATT
Chicago

The history of diabetes is marked by the recurrence of certain ideas which rise, decline and disappear, only to make a new appearance and go through a similar cycle again in an altered form, and a new generation. This is notably true of trends in diet. Certain conceptions recur more often and tend to stay with us longer and longer until we come to regard them as permanent.

Calorie Magnitude of the Diet. The conception that overnutrition is detrimental to health in the presence or absence of diabetes, and in its presence, specifically so, appears to be true. An extension of this idea is to the effect that in diabetes some degree of undernutrition favors the preservation of natural carbohydrate tolerance or of its partial rebuilding or restoration in cases in which restoration is possible. When tolerance has sunk to the vanishing point and remained there in spite of all efforts to build it up, for a long enough time, then, until future discoveries change the picture, we must consider the natural tolerance dead, burnt out or beyond recall. When this stage is reached, there is no longer hope

*Delivered October 30, 1933 before the joint meeting of The New York Academy of Medicine and the Medical Society of the County of New York.

of preserving or rebuilding natural tolerance by any present day method. However, even in this situation it is held that undernutrition may increase the effectiveness of the unit of insulin, permit one to use a smaller dose, and make the management generally smoother and safer. Joslin recommends as a general rule that, in the case of a diabetic patient of a given age, height and sex, the diet should be restricted enough to keep the body weight 10 per cent below the average for normal subjects of the same age, height and sex, as shown on standard statistical tables. Probably if this rule were followed in every case the advantages gained would outweigh occasional disadvantages. There are exceptions to every rule. Still, all things considered, most writers agree that overnutrition is undesirable and that it is better to keep a patient spare and under—rather than overnourished. Accordingly, the calorie magnitude of the diet should be adjusted to keep the body weight at the level desired.

Protein Limitation. Another conception that has returned persistently through the years and has come to be looked on as fairly established, is that an excess of protein is undesirable. Here again opinions will vary for some time to come as to the desirable limits of protein restriction. For adults, an allowance of somewhere between 0.75 and 1.25 gm. per kilo per day might meet the approval of most modern writers. For growing children a larger allowance is recommended by pediatricians, *i. e.,* 2.0 to 2.5 gm. per kilo.

Carbohydrate and Fat. Having fixed the number of total calories and the quantity of protein (which determines the number of protein calories) there will be a calorie remainder to be supplied by carbohydrate and fat, and whatever quantity we use of one will determine the quantity of the other, for if the total non-protein calories were 1500 and if we used 150 gm. of carbohydrate, producing 600 calories, we would have to use 100 gm. of fat to make up the 900 calorie balance. The question then arises as to how much of each may best be employed—or stating it more simply, how much of either.

In some of the older rigid diets or diets of the types associated with the names of Newburgh and Marsh or Petrén of Sweden, the carbohydrate has been reduced to a minimum. In some of the diets of Newburgh and Marsh it has represented but 5 to 10 per cent of the non-protein calories, the remainder being supplied by fat, and this implies that the fat outweighs the carbohydrate roughly 8 or 4 to 1. However, the total quantity of fat or carbohydrate depends not merely on the relative proportions but also on the total magnitude of the diet. With a diet containing 1700 non-protein calories the above ratios would indicate 20 to 40 gm. carbohydrate and 170 to 180 gm. fat, whereas, with only 1000 non-protein calories, they would indicate not over 105 gm. fat. All such diets are sometimes referred to as "high fat" diets without regard for magnitudes but only the larger ones are absolutely high in fat. The smaller are actually low in fat. But they all have in common *low carbohydrate.*

In contrast with the above are diets containing larger quantities of carbohydrate, and all other factors remaining the same, correspondingly smaller amounts of fat. They are referred to by some as "high carbohydrate" diets or by others as "low fat" diets—depending on the author's idea as to whether elevation of the carbohydrate or depression of the fat is the more important consideration. The employment of diets of this description is by no means a recent innovation. Allen states that according to Stokvis milk was recommended for diabetes by almost all writers in the 18th century, and that Richardson credits a "Dr. Smart of Edinburgh" with priority in the use of a formal "milk cure." In any event, in 1874 Donkin published a paper on diabetes mellitus successfully treated with skimmed milk, which became widely known and started the movement. He gave diets of low calorie value consisting almost entirely of skimmed milk. One hundred grams of skimmed milk may contain 5 gm. carbohydrate, 3 gm. protein, 0.3 gm. fat, and about 35 calories. To provide, let us say 1750 calories, the quantity of skimmed milk required would be 5 liters. This would contain 250 gm. carbohy-

drate, 150 gm. protein and 15 gm. fat (C:F ratio 17:1). A whole milk diet of the same calorie value would contain approximately 125 gm. carbohydrate, 75 gm. protein and 100 gm. fat (C:F ratio 1.25:1). So milk diets may have compositions corresponding closely with those of modern "high carbohydrate" diets.

Following Donkin, many writers employed his methods with good results, and "milk cures" in one form and another remained in use for a long time. They have been recommended as useful in some situations by such noted authorities as Naunyn (1896), and von Noorden (1898 to 1910), and were reindorsed by Winternitz and Strasser (1899). Again, as late as 1915 their beneficial effects were pointed out by Williamson and by La Farge, the latter believing that the lactose in milk was particularly well tolerated, and that it increased the tolerance for other carbohydrates. But milk cures never enjoyed a vogue in the United States, although they were doubtless tried by individuals.

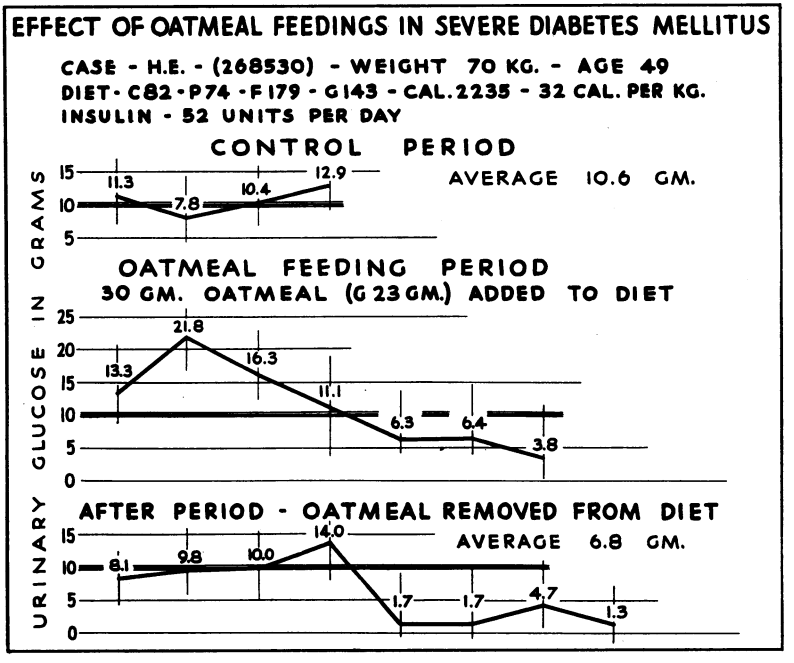
The von Düring vegetable cure first described in 1868, consisted in the administration of rice or other cereals, some bread, fruits, milk, wine and a rather liberal allowance of meat. The von Düring diets were low in calories, high in carbohydrate, moderate in protein and low in fat. Their composition can not be stated exactly. Beneficial results were often obtained by von Düring and others who followed his methods.

The Mossé "potato cure" so called, first described in 1898, involved the use of liberal or even enormous quantities of potato. This method enjoyed a vogue in France. The alleged benefits were attributed to specific properties of the potato. We may allow for gross exaggerations of the percentage of cases in which beneficial results were really obtained by the Mossé method, and still understand how a diet composed more or less exclusively of potatoes may be high in carbohydrate, low in protein, low in fat, and easily low in total calories. More than 2 kilos of boiled potatoes would be required to provide 1800 calories. In the light of present day knowledge there is little

doubt that the reputation of the Mossé potato cure rested on the occasional observation of the same type of results as those observed with the Donkin or Düring "cures."

The "oatmeal or oat cure" as described by von Noorden (Zuckerkrankheit, 5th ed., p. 312, 1910) consisted of 250 gm. oatmeal, 200 to 300 gm. butter, and 100 gm. of vegetable protein or 5 to 8 eggs. It might therefore, contain C.161, P.140, F.185 to 270 gm. and yield in round numbers 2900 to 3700 calories, depending on the quantity of butter employed. With the eggs in place of the plant albumin, the protein would be 30 to 50 gm. less, and the fat 30 to 50 gm. higher, so that the fat might rise to the high extreme of 320 gm. Such a ration would have to be described as a high calorie, high carbohydrate, high fat diet, with moderate protein (70 to 140 gm.). The fat exceeds the carbohydrate sometimes as much as 2 to 1. Concerning the "oat cure," von Noorden says, "It is of extraordinary practical significance; the theory of its action however, presents a most difficult problem. I discovered its significance quite accidentally. Some patients in my clinic were troubled with severe disorders of the stomach and bowel. I therefore gave them oatmeal gruel. Remarkably enough, the glycosuria did not increase, but became much less than it had been before on the most rigid diet. This became the starting point for further researches which were continued most carefully for two years before I ventured to publish the paradoxical facts." *Several days on a rigid diet and 1 or 2 days on a low vegetable diet usually preceded the oatmeal diet,* which was then given for 3 or 4 days and followed by 1 or 2 vegetable days. Continuing the quotation—"In suitable favorable cases it is observed that in the beginning of the oat cure the glycosuria frequently rises somewhat; but after several days it sinks decidedly, and with it or even to a relatively greater degree, the ketonuria sinks. Often even during the first oat period one obtains entirely sugar free urine; if this is not the case, one may still count on it with fair certainty during the following vegetable days." "Whoever considers the tables without prejudice must admit that results were

obtained with respect to glycosuria and ketonuria that one would not have thought were possible before. *Unfortunately, there are relatively few cases in which the results are so surprisingly favorable;* in other cases the results were entirely absent or only partial." In 1910 von Noorden believed that the favorable results obtained with other cures—Donkin's von Düring's, Mossé's, etc., were due to the use of simple rations containing but one kind of carbohydrate, and that the oat cure was similar in this respect, but that it was superior to others, and owed its superiority to specific properties of oats.



The oatmeal "cure" led to studies of various cereals and cereal diets by Falta, Porges, Salomon and others. Porges discarded von Noorden's belief in the specificity of oats, but held to the view that it was necessary to use but a single cereal or carbohydrate. However, Falta effectually dispelled this misconception by obtaining the same results with various cereals and cereal mixtures. He stress-

ed the importance of *protein restriction* in kind and quantity. In 1911 Klemperer appears to have shown that results quite analogous to those observed in the course of an oat cure could be produced by the use of glucose alone, and it is remarkable how many years had elapsed, and how much work had been done with complicated mixtures and intricate theories before pure sugars were experimentally tested. The literature on this subject continued up to the time of the war. It was almost entirely European.

The following years saw a rapid development of research in this country, especially in the field of metabolism and diabetes, but interest ran in other channels. There was an inclination toward skepticism concerning the phenomena said to occur in the course of "cures" and to think that there was nothing mysterious about them. I erred for one in averring at one time that their reputation rested on faulty measurements of the glucose supply, in a paragraph quoted by Graham Lusk. Allen said also in 1919—"The rationale of the carbohydrate 'cures' appeared mysterious when diabetes was regarded as a deficiency of carbohydrate assimilation, but becomes clear with the understanding of diabetes as a general disorder of the metabolism." He felt at that time that the preliminary undernutrition and limitation of fat and protein accounted for all the alleged results.

Before proceeding, let us look at a chart (see Figure) which shows the phenomenon under discussion. A male patient with severe diabetes who had been for nine years on insulin treatment and had served repeatedly in feeding experiments, was forty-nine years old, 5 ft. 9 in. tall, and weighed 154 lbs. or 70 kg. The patient was not confined to bed but did light and standardized physical work. The diet contained carbohydrate 82 gm., protein 74 gm., fat 179 gm., calories 2235 (32 cal. per kg.). The insulin was adjusted to allow the excretion of an easily measurable quantity of sugar. The dose of insulin was 52 units. He was kept on this diet and insulin dose until for 10 days the sugar excretion had varied not more than 3 gm. above or below a mean of 10. Then, as a simple superposition on his

regular diet, he was given 30 gm. oatmeal daily for 7 days, in which all other factors remained the same. This quantity of oatmeal contains 113 calories and 23 gm. of glucose equivalents. The oatmeal period was followed by an after period in which conditions were the same as before. It will be seen that the sugar excretion rose temporarily and then fell below the original level, as described by von Noorden during an oat cure. After withdrawal of the oatmeal the glycosuria returned to its former level for 3 days, then disappeared except for a trace.* It may be noted that the patient was of nearly average weight for his height and not undernourished during the experiment. The addition of the oatmeal increased the calories by 113. The diet was high in fat throughout and of a type that the patient had used for years. The effect would have to be ascribed simply to the *addition* of the cereal or, as it is possibly safe to say, the simple *addition of carbohydrate.*

At the end of the experiment the patient was apparently utilizing (burning, storing or both) 32 gm. more glucose than he had been before, although the insulin dosage remained the same. If, as Klemperer held, the same type of result may be obtained with feedings of glucose alone, the effect would seem to be that of the *carbohydrate.* But during the fore period there was at all times an excess of sugar in the body, and we might wonder why this was less available to the body than administered sugar. Although several hypotheses have been advanced to explain the phenomenon, it still presents an interesting problem for further investigation.

Now, resuming the narrative, after the war dietary trends in this country were generally toward low calorie, low protein diets in which the total quantity of fat was moderate, but usually higher than the carbohydrate. Meanwhile, Falta, Porges and others in Europe continued the use of cereal diets. With the advent of insulin in 1921,

*By the Folin-Berglund method of sugar determination employed the fractions to the right of the decimal are within normal limits.

American writers still adhered to the types of diets that they had been using, although insulin now permitted them wider latitude. In 1926, Geyelin, working with diabetic children, had had certain cases in which it was difficult to control the glycosuria without inducing insulin reactions. In view of the emphasis that had been laid on the harmful effect of fat in this country, it was natural to consider the possibility that the fat in his diets might be to blame. He therefore reduced the amount of fat and supplied the necessary calories with carbohydrate, prepared to use larger insulin doses, but as he states, he was "surprised" to find that the insulin requirement was not increased, and that in some adults it was actually lowered. Geyelin used diets containing 2, 3 or more grams of carbohydrate per gram of fat. Meanwhile, Sansum, Blatherwick and Bowden had reported results with insulin cases on diets high in carbohydrate, which they had come to adopt for general reasons. These papers by Sansum et al and Geyelin have been followed by others here and abroad, such as those of Rabinowitch, Porges and Adlersburg and others, to which Dr. Geyelin may refer tonight, so that now in the insulin era we are in the midst of a "high carbohydrate" movement in which we discern an awakening on this side of the Atlantic, and a revival in England and Europe, of interest in a type of diet and a problem of mechanism that has held the attention of groups of writers more or less continuously for 60 years. And in the course of the movement we see the recurrence with variations of certain conceptions and possibly also some of the errors that have been discussed at great length in the pre-insulin era. However, now we are better equipped than earlier writers to solve the theoretical and practical problem.

Mechanism of High Carbohydrate Diets. As stated above, the idea that led Dr. Geyelin to adopt high carbohydrate rations for children was that his diets had been too high in fat. As he is here tonight, he will correct me if I misrepresent him in stating that what he was after was low fat diets, and that in lowering the fat while keeping the calories and protein about the same, he necessarily

raised the carbohydrate. Then, having obtained his striking results, he interpreted them as due in part, at least to the positive action of carbohydrate.

The influence of the same conception concerning the injuriousness of fat is evident in the interesting experimental study of Dr. Russell Richardson of this city. Working with patients on diets of the high fat type but of moderate calorie magnitude, he kept the urine free of sugar and the blood sugar percentage within normal limits with certain fixed doses of insulin. He was then able to remove from a diet a given weight of fat and add the same *weight* of carbohydrate without changing the dose of insulin or causing glycosuria or hyperglycemia. Thus in one case the diet provided C.57, P.58, F.150, Cal.1930. The insulin dose was 46 units, the blood and urine were normal and the patient was free of insulin reactions. The fat was then lowered by 93 gm. and the carbohydrate increased by 93 gm. so that the diet provided C.150, P.58, F.57, Cal.1345. With the insulin dosage remaining the same, the blood and urine remained as before. He found that such changes could be made all at one time with patients who had been somewhat undernourished. With obese patients the experiment failed, sugar appearing in the urine when the change was made. Richardson says "There is apparently present in these patients the *influence of the body fat* which makes it impossible for them to take advantage of *the reduction of fat in the body*" and further "We feel that the ability of patients to metabolize more carbohydrate can not be due to increased tolerance for food (glucose)—No time was allowed for development of a great tolerance—The patients were also on the highest diet which they could take with the given amount of insulin—In the insulin patients if the insulin had been sufficient to allow for a marked increase in carbohydrate, it would have been sufficient to cause shock during the period of the low-carbohydrate high-fat diet." He suggests a reciprocal relation between the fat and the carbohydrate metabolism.

Now it must be said of these experiments that three changes are made simultaneously — lowering of the fat and total calories and raising of the quantity of carbohydrate. There is little question that in undernourished or even normally nourished patients who have been living on diets absolutely too low in carbohydrate it may be possible to obtain results similar in kind to those obtained by Richardson simply by adding carbohydrate, as has already been shown. Nevertheless it may be recalled that carbohydrate is convertible in the body into fat and that fat may be burned directly as such. Indeed under suitable physiological conditions a major fraction of all the utilizable carbohydrate that enters the body may be oxidized indirectly by primary reduction to fat, a two stage process in which the total quantity of oxygen consumed and the total quantity of carbon dioxide produced are the same in the end as they would be if the sugar were burned directly. Therefore, what we refer to as a patient's tolerance for carbohydrate depends not alone on his ability to oxidize sugar directly, but in a very considerable measure on his ability to burn it indirectly, that is to say—by primary conversion into fat and ultimate burning of the fat. Even if we granted the theoretical contention of some writers that fat may be changed into carbohydrate, the above statement would hold. The question may be raised as to the possible limits of fat formation from carbohydrate, and as to the relative availability of this method of sugar disposition in a fat as compared with a lean individual. As the fat reservoirs of the body fill up and the body approaches fat saturation, then, other factors remaining the same, might we not expect a slowing down of the rate of conversion of carbohydrate into fat, and a corresponding impairment of the carbohydrate tolerance? Perhaps this is what Richardson had in mind, and if so I believe that he offers a plausible theory of how too much fat in the body may lower the tolerance for carbohydrate. However, in the case of a patient who is already spare and undernourished, it would seem to me doubtful whether the removal of fat from the diet would serve the same pur-

pose. In such cases it would seem necessary to attribute any increase of the tolerance for carbohydrate to the positive action of carbohydrate itself, or to be very cautious—something contained in carbohydrate foods. The mechanism of the positive action of carbohydrate food remains problematic.

Practical Adjustment of the Proportions of Carbohydrate and Fat. If in the case of a given patient weighing 60 kg. general requirements had been fairly fulfilled by a diet containing 1800 calories, 240 of which were provided by 60 gm. protein, leaving 1560 non-protein calories, and if the carbohydrate amounted to 60 gm. and the fat to 146 gm. the diet would be of a relatively high fat type, and the question would rise as to whether conditions would be improved by the addition of carbohydrate and the subtraction of fat. One might then remove say 10 gm. of fat, add the calorie equivalent or 22.5 gm. of carbohydrate, observe results, and if they were desirable, repeat the process. If after 2 to 3 or 4 steps the insulin requirement were found to rise, one might stop or reverse the procedure. Or, if, after the carbohydrate had risen to 140 to 150 gm. and the fat had fallen to 85 to 80 gm. the patient felt that he was not receiving enough fat foods such as butter, cream or oil to make his menus agreeable to him, one might stop for no better reason than that. In a number of our cases in which we have followed roughly such a procedure, there have been definite advantages in raising the carbohydrate to levels between 2 and 3 gm. per kg. of body weight. I have not been struck by additional advantages resulting from further elevation of the carbohydrate using as criteria the insulin requirement per *calorie* of diet, frequency of reactions and the comfort of the patient. In some cases conditions have been less satisfactory on diets too high in carbohydrate. I have had but a limited experience with very high carbohydrate diets, and shall listen with interest to Dr. Geyelin. It has seemed to me that the most effective diet would be one on which the patient would obtain the necessary number of *calories* on the lowest possible insulin dose.